Conventional Microscopy vs. Computer Imagery in Chiropractic Education

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Purpose: As human tissue pathology slides become increasingly difficult to obtain, other methods of teaching microscopy in educational laboratories must be considered. The purpose of this study was to evaluate our students' satisfaction with newly implemented computer imagery based laboratory instruction and to obtain input from their perspective on the advantages and disadvantages of computerized vs. traditional microscope laboratories. **Methods:** This undertaking involved the creation of a new computer laboratory. Robbins and Cotran *Pathologic Basis of Disease, 7th ed,* was chosen as the required text which gave students access to the Robbins Pathology website, including complete content of text, Interactive Case Study Companion, and Virtual Microscope. Students had experience with traditional microscopes in their histology and microbiology laboratory courses. Student satisfaction with computer based learning was assessed using a 28 question survey which was administered to three successive trimesters of pathology students (n=193) using the computer survey website Zoomerang. Answers were given on a scale of 1-5 and statistically analyzed using weighted averages. **Results**: The survey data indicated that students were satisfied with computer based learning activities during pathology laboratory instruction. The most favorable aspect to computer imagery was 24–7 availability (weighted avg. 4.16), followed by clarification offered by accompanying text and captions (weighted avg. 4.08). **Conclusion**: Although advantages and disadvantages exist in using conventional microscopy and computer imagery, current pathology teaching environments warrant investigation of replacing traditional microscope exercises with computer applications. Chiropractic students supported the adoption of computer-assisted instruction in pathology laboratories. (J Chiropr Educ 2008;22(2):138–144)

Key Indexing Terms: Microscopy; Digital Library; Computerized programs; Education; Chiropractic

INTRODUCTION

With today's growing world of technology, there are numerous choices for presenting educational laboratory materials. One such choice is laboratory instruction involving conventional microscopy potentially being replaced by computer imagery. Although educational institutions may chose not to completely replace microscopes, the advantages of computerized imagery and technology for health care education must be considered.[1,2] Do students perceive that they can learn as well or better from a computer as compared to traditional microscopes and tissue slides in a physiopathology laboratory? The main problem in physiopathology courses is the increasing difficulty in obtaining human tissue pathology slides from medical supply companies. This seems to be due to the red tape, expense, and legal issues involved with human tissue procurement. This is evidenced in the March 2007 submission to the Health Select Committee on the Human Tissue Bill. (http://www.nzord.org. nz/internal.asp?CategoryID=100009&SubCatID= 2100066& ArticleID=100224) Complete slide digitization is now a

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possibility to replacing glass slides, thus alleviating these problems.[3]

Recently, as technology now permits, other health care schools including medical and chiropractic have decided to utilize computer digital images in their courses involving microscopy.[2,3–7] Our institution decided to incorporate computer digital images into the laboratory of our physiopathology course. The first step in this endeavor was to investigate available options for computerized imagery including software programs and internet websites, as well as to establish a computer laboratory. Our educational goal was to adequately present to our students the morphologic changes that occur in the pathogenesis of disease using computer imagery.

After determining the appropriate computerized system to meet our needs, it was necessary to assess how the computer imagery compared to standards of traditional microscopy from a student's perspective. The first successful attempt to assess virtual microscopy, that is a slide that allows for navigation and magnification changes,[6] was in the new Medicine program at the University of South Wales in 2004. In this study, students overwhelmingly approved computerized virtual images while faculty perceived an increase in efficiency of their teaching.[7] A study done at the University of Basel, Switzerland using virtual slides for instruction of medical students and continuing medical education, concluded in 2005 that most students regarded virtual slides as adequate replacement for traditional slides.[5]

In making this change from conventional microscopy to computerized imagery, we wanted to determine if chiropractic students were satisfied with their new learning experience. This study addressed the need to conduct research on instructional methods within the chiropractic educational environment.[8] The purpose was to evaluate our students' satisfaction with computerized imagery based laboratory instruction and to obtain input from their perspective on the advantages and disadvantages of computerized vs. traditional microscope laboratories. As a comparative reference between conventional microscopy and computerized imagery, our students participated in traditional microscope exercises in their previously completed histology laboratory and their concurrently enrolled microbiology laboratory. Although performance outcomes may be used to assess the effectiveness of instructional methods, student satisfaction with a newly adopted instructional method is another important component of feedback related to the assessment of the learning environment.[7,9–11] Our survey design is consistent with previous literature in medical education to assess student satisfaction with computer imagery.[9–16]

METHODS

Selection of Computerized Educational Resources

In our attempt to replace microscope slides, we wanted to ensure that our students had access to computer images which would allow them to change magnification and scan the tissue, as opposed to simply observing still images. This virtual imagery on computer simulation would give the students an opportunity to have more of a real microscope experience by enabling them to interact with the presented material.[3] It is only recently that it has become possible to digitize entire pathology slides at various magnifications to allow for exploration of the slide on the computer in a manner similar to a real microscope.[5] We found that there was a limited amount of software available that could perform this feature. Those that were available poorly mimicked real microscopy features and were cost prohibitive.

After much investigation and searching, we came across our solution when we were introduced to Robbins and Cotran *Pathologic Basis of Disease, 7th ed.,*[17] and chose this as the required text for the course. The purchase of the text gives students a pin number which allows access to the Robbins Pathology website.(http://www.robbinspathology.com) The website includes the complete written content of the text as well as an image library with all images and charts. All illustrations can be downloaded and saved as individual files for each individual laboratory session to keep the student well organized. Another feature of the website is access to the Interactive Case Study Companion. This allows students to work through case studies which give excellent patient presentation including patient history, clinical signs and symptoms, results of physical exam, and any pertinent diagnostic testing. Students work through the case studies viewing both gross and histologic images pertaining to the case. The questions included in the case exercise require the students to apply the pathology they have learned to the pathogenesis of a particular case. The decision about what cases we could present was no

longer limited by the availability of our representative microscope slides. Instead, the computer website and imagery afforded us an extensive breadth of pathology cases, broadening our opportunities for instructing.[5]

The feature of this website that really interested us as far as replacing our microscopes was the Virtual Microscope section. While the atlas style of the image library is of instructional value, the design falls short of what students can learn from a real tissue section.[7] Here the initial histologic specimen is shown and annotations give an explanation of orientation for the tissue section. Students can then zoom in and magnify as well as scan the entire section. A written description is given to point out important physiopathologic changes occurring in the tissues at various magnifications. Finally, Virtual Microscope gives the students a clinicopathologic correlation which turns the virtual image from just another pathology slide into a real patient with clinical relevance. Virtual slides also give the advantage of increasing the number of available pathology slides for instruction without concerns for breakage and quality of stains fading with time.[6]

Development of Computer Laboratory

This undertaking also involved the creation of a new computer laboratory at our institution, consisting of 32 student terminals as well as a teacher dedicated computer linked to a projector and screen. Students would spend half of the two hour weekly laboratory session working independently at their own computer terminal. The remainder of the laboratory consisted of faculty led group discussion and review of important principles introduced in that laboratory session using the image library, virtual microscope, and interactive case studies.

Design of Student Assessment

Finally, we wanted to assess how our students' perception of learning using the computer laboratory compared to their previous microscope laboratory courses. The computer survey website Zoomerang (http://www.zoomerang.com) was utilized as we wanted to survey our students using the same technology and educational medium they were using in their laboratory sessions.

Implementation of computer based learning was assessed using a 28 question (Appendix A) survey which was produced and administered to successive classes for one academic year of Physiopathology students (n=193). Responses were based on a scale of 1–5 (strongly disagree, disagree, neutral, agree, and strongly agree). The survey addressed the instructional environment, student learning, efficiency of laboratory instruction, and product feedback related to the website, image library, virtual microscope, and case studies. The survey also addressed the importance of group discussion, as this product is a self-directed learning tool. In addition, general written comments were also solicited. Descriptive statistical methods were used to present the data as weighted averages and frequency distribution tables (Table 1).

The survey was administered during a laboratory session at the end of the trimester for one academic year. A response rate of 82% was achieved for our assessment (158 students out of 193). The administration of our survey via Zoomerang was deemed equivalent to a "survey mailing", because our students did not have to respond. Babbie[18] reports that a response rate of 60% for mailed questionnaires should be considered a "good" representation of the study population. The inherent limitation of survey data is the underlying assumption that responders and non-responders are equally representative of the study population when the response rate is deemed adequate. Although class sizes per trimester varied throughout the academic year, there were no obvious discrepancies in the response distributions, i.e. repeated administrations of the survey, to indicate poor reliability or bias in our survey data.

This research was deemed exempt from the need for an institutional review board because the research was conducted in an established educational setting involving normal educational practices; the research assessed the effectiveness of an instructional method.

RESULTS

The students agreed that the instructional environment of using computerized imagery increased their access to and understanding of course materials (Table 1, questions 1 and 3). The majority of students agreed that computer imagery laboratories enhanced their learning as compared to microscope laboratories (Table 1, questions 4–7). Overall, the students were neutral towards the computer imagery laboratories improving the efficiency of laboratory instruction with a relatively equal distribution of rankings among disagree, neutral, and agree (Table 1, questions 9–15). The students were neutral towards navigation of the Robbins Pathology

Table 1. Survey Data

Question Number	Respondents (158 out of 193 students who took the course)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Weighted Average
1	158	3	13	25	59	58	3.99
2	158	6	27	44	62	19	3.39
3	158	2	8	25	73	50	4.02
4	157	4	6	37	72	38	3.85
5	158	8	21	57	46	26	3.39
6	158	5	9	51	64	29	3.65
7	157	2	16	36	67	36	3.76
8	156	28	59	41	19	9	2.50
9	158	5	22	54	56	21	3.42
10	157	10	35	28	54	30	3.38
11	156	6	40	35	53	22	3.29
12	158	6	49	44	43	16	3.09
13	156	8	32	49	51	16	3.22
14	158	20	56	44	32	6	2.67
15	157	6	25	47	73	6	3.31
16	158	17	33	32	64	12	3.13
17	158	4	17	27	80	30	3.73
18	158	1	7	28	79	43	3.99
19	157	1	9	12	77	58	4.16
20	156	2	5	20	81	48	4.08
21	156	1	6	42	86	21	3.77
22	157	3	47	61	38	8	3.01
23	158	2	12	46	80	18	3.63
24	156	3	8	34	83	28	3.80
25	157	1	3	25	97	31	3.98
26	158	0	10	25	90	33	3.92
27	157	7	17	26	68	39	3.73
28	158	9	31	39	69	10	3.25

website (Table 1, weighted average 3.13). However, there was a disproportionate number of respondents (N=64) that agreed that navigation was acceptable to them (Table 1, question 16).

The most favorable aspects of computerized imagery laboratories with the majority of students agreeing, was the quality of computer images (Table 1, questions 17–18) and accompanying text (question 20) were acceptable and useful respectively (Table 1).The majority of students agreed (n=86, n=80) that virtual microscope features enhanced their understanding of pathology (Table 1 question 21 and 23), but as a learning tool, students preferred to use the computer image library (Table 1, question 22). The majority of students agreed (~75%) that the case study component of the computer laboratory was well organized and useful to their understanding of pathology (Table1, questions 24–26) The students were neutral towards agreeing that group discussion was a useful component of laboratory instruction (Table 1, questions 27–28). These results are representative of each of three trimesters the survey was administered. As such, the cumulative frequency distribution and weighted averages over the three trimesters were deemed accurate.

DISCUSSION

The survey data showed an overall positive satisfaction of students with computer imagery compared to conventional microscopy. The most favorable aspect to computer imagery was the around-the-clock availability of the learning materials (weighted average 4.16, question 19). When using traditional microscope labs our students only had access to the pathology slides during their two hour laboratory session. Any extra slides we had were made available in the library, however as we were running out

of pathology slides this became increasingly limited. With the computer website, students had access to the required material any time or place they had access to a computer and the Internet. This is especially helpful for self-testing and review prior to an exam compared to the difficulty in traditional microscope labs with less access to the materials.[2,19]

The next most favorable aspect was the clarification offered using computer imagery by the accompanying text and captions associated with each image (weighted average. 4.08, question 20). The computers can "talk" to the students giving orientation, additional material, and clinicopathologic correlation that the "silent" microscope does not offer. This integration of images, animations, and text using computer technology can enhance the student's learning experience. It also allows them to work and learn at their own pace, time, and place allowing for more self-directed learning.[2,20]

Other favorable aspects included that students felt the computer images were easier to view and understand (weighted average 4.02, question 3). The interactive case studies and incorporated images also received high marks from the students, both in presenting clinical correlation of course material (weighted average 3.98, question25) and in their clear and organized manner of presentation (weighted average 3.92 question 26).

The lowest weighted average response (weighted average 2.50, question 8) referred to whether the students wanted a greater amount of faculty led group discussion and review during the lab. Students seemed to like the computers and wanted most of the allotted class time to learn and work independently as long materials are adequately made available.

Based on the survey response, we found that although students strongly preferred the around-the-clock availability of the website and computer images, when asked if they prepare in advance for a lab session, their response was neutral (weighted average 3.09, question 12). When asked if their work is not finished in the allotted class time did they access the material outside of class and complete the lab, responses went up, by 0.20 (weighted average 3.29, question 11). These responses suggest that while most students seem to like the additional access to course material, they may not always use it to their full advantage. The interpretation of their neutral response to the amount of work being assigned indicated that we were not overwhelming them with information and technology. However at the same time, we need to further address potential learning activities that will take better advantage of the accessibility and efficiency of the virtual microscope laboratory and promote critical thinking skills.

Although traditional microscopy may be deemed important so that students gain an appreciation of the source of tissues and the images, this may be achieved with a projection microscope operated by a trained educator in histology and pathology.[10,12,15,16] As the majority of practicing chiropractors do not use a microscope, laboratory instruction related to operation of the microscope and the identification of "remarkable" and/or variant structures from single slides can be replaced with computer applications that emphasize active learning, not memorization, of pathology relevant to becoming a practicing chiropractor within an integrative health-care team.[12] Communication barriers between faculty and students in visualizing glass slide images also promotes a passive learning environment; whereas, computer applications promote group (classroom) learning activities as tissue specimens can be presented and studied without ambiguity to facilitate learning of relevant pathology for clinicians and improve efficiency of laboratory instruction.[12,15]

Although students had a favorable response to learning physiopathology using computerized imagery, there are still advantages and disadvantages to each methodology. One advantage to computerized imagery is the increased availability of the learning material to the students outside of scheduled class time. Another advantage is the way the computers "talk" to the students through written accompanying text which can, orient, explain, add additional educational material and make clinical correlations.

Disadvantages are that many, but not all of the images are available as Virtual Microscope with the ability to scan and magnify. The quality of the virtual images, while good, still does not offer as sharp a resolution as traditional microscopy does. It takes longer to scan and magnify the computerized images. As magnification is increased the images often blur momentarily, and will refocus, however the process does take a little longer. Acquisition speed is still a central weakness of most existing virtual slide acquisition systems.[5] Since we were using a website, we were dependent on the Internet functioning well. Occasionally we experienced problems with our server which made accessing the computer images problematic.

The advantages then to traditional microscopy include the speed at which one can scan and magnify

a pathology slide with better resolution of the image. The microscopes also are not prone to computer related problems such as Internet access. The disadvantages include limited access to microscopes and pathology slides outside of regular class time, the microscope being "silent' and not adding any additional information, and the increased difficulty in obtaining human tissue pathology slides.

CONCLUSION

Our educational goal in this study was to investigate and find an alternative method to traditional microscopy in order to successfully present the morphologic changes associated with the pathogenesis of disease to our students. Computer imagery can provide a more varied educational experience and provide tools for educational inquiry and problem solving.[1] Although advantages and disadvantages exist between conventional microscopy and computer imagery, existing problems in obtaining human pathology specimens warrant the investigation of other teaching methodologies. Our purpose in obtaining feedback from our students was to ensure a quality learning experience they felt comfortable with. Descriptive statistical methods demonstrate that chiropractic students support the adoption of computer-assisted instruction in pathology laboratories.

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APPENDIX: A--SURVEY QUESTIONS

Questions concerning the laboratory itself:

1. Computer laboratories are favorable since the material is accessible 24 hours a day.
2. The computer laboratory is a comfortable learning environment.
3. The images in the computer laboratory are easier to view and understand than in a microscope laboratory.

Questions concerning learning:

4. It is easier to learn the material using computers rather than microscopes.
5. In general, I learned more in the computer laboratory than in previous microscope laboratories.
6. The material is conveyed with more clarity using the computer laboratory than with microscopes.
7. Learning in the computer environment is favorable since I can work at my own pace.
8. I wish there was more lecture involved during the computer lab.

Questions concerning the amount of time spent/work done in the computer laboratory:

9. In general, I find myself working more in the computer laboratory than in a traditional microscope laboratory.
10. In general, I feel there is not enough time to finish the material in the time allotted for each laboratory.
11. If I do not finish the material in the allotted time, I typically access the material outside of class time and complete the lab before the next laboratory session.
12. If I typically do not finish labs in the allotted time, I try to prepare some of the laboratory work prior to the scheduled session.
13. When compared to microscopes, the amount of time that is spent learning the material is shorter.
14. I feel as though more work could have been assigned to us in a computer laboratory than in a traditional microscope laboratory.
15. The amount of work assigned to a given laboratory session was a fair and adequate amount.

Questions concerning the Robbins Pathology Website:

16. The website is set up in clear and organized manner making it easy to navigate through.

Image Library:

17. Compared with conventional microscope imaging, the website images are easier to use.
18. Material from the image library is clearer since the pathology shown does not need to be scanned and searched for as in conventional microscope imaging.
19. The image library is better since the website can be accessed anytime whereas in traditional microscope lab material can only be accessed during specific class time.
20. The accompanied text and captions of the image library offers explanation and clarification traditional microscopy does not.

Virtual Microscope/Microscope Slides:

21. The virtual microscope images and microscope slides add additional support and explanation to the concepts being presented in lab.
22. The virtual microscope images and microscope slides are better learning tools than the image library pictures.
23. The ability of the virtual microscope and microscope slides to scan tissues and increase magnification gives the student a better understanding of the pathology being presented.

Case Studies:

24. The case studies are a useful review of the lab and lecture material.
25. The case studies are useful in presenting clinical correlation of lab and lecture material.
26. The case studies are put together in a clear and organized manner.

Questions concerning class discussion/student participation:

27. The reviewing of material as a group is helpful in clarify the concepts being presented.
28. The approximately equal amount of time spent doing individual student work on the website and group review of the material was adequate and appropriate.
29. Opportunity to add general comments